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ABSTRACT

Presented is an overview of a project designed to carry on the review of research in science education begun by Francis D. Curtis who published, beginning in 1926, three "Digests of Investigations in the Teaching of Science in the Elementary and Secondary Schools." The current project involved both the reprinting of the three Curtis publications and the reviewing of published science education research literature for the period 1937-1957. Also included in this paper are descriptions of the types of research studies included in the six volumes and several questions which might be raised concerning research in science education. (PEB)

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FORTY YEARS OF RESEARCH IN SCIENCE EDUCATION*

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In 1926 Francis D. Curtis completed his "diligent search" of the pedagogical literature of the past twenty years and had published A Digest of Investigations in the Teaching of Science in the Elementary and Secondary Schools. He followed this with the "Second" and"Third" Digests which provided reviews of science education research through the year 1937. Curtis included in these volumes references to unpublished studies and these Digests now probably provide the only access to many of these studies.

The "Curtis Digests" were long out of print and generally unavailable to science education researchers and practitioners. Also, research continued, and there was no comprehensive guide to the research literature in science education for the period, 1937-1957. At the urging of many leaders in the National Association for Research in Science Teaching and science education students, it was decided to extend the digests through 1957 and to try to reprint the "Curtis Digests."** These six volumes of Reviews of Research in Science Education are now available to researchers and practitioners in science education.[1]

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**We are indebted to Frederick L. Fitzpatrick for early help and guidance in getting this project underway.

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Selection and Nature of the Reviews

The nature of the reviews is a function of the definition of science education research, the objectives of the undertaking, the search and selection procedures, and the methods of digesting and annotating the studies. Because this project was carried out over a period of about 50 years and by several different people, the procedures used are not exactly the same in each of the volumes. (Even Francis Curtis changed his procedures from volume to volume.) These differences probably do not affect the general usefulness of the volumes but do make it more difficult to compare the work done in different periods.

The definition of science education research. A relatively broad definition of science education research has been used: "Science education research is the systematic attempt to define and investigate problems involved in learning and instruction in science." A primary function of the "Reviews" is to serve as a guide to the research literature of science education. Therefore, an attempt has been made to be quite inclusive. The user may find studies that he wishes to reject, but we have considered science education studies within a broad definition of science education research. This makes a wide range of studies available to users who have a variety of reasons for tapping the results of science education research.

Function of the "Reviews"

The possible functions of the "Reviews" are as follows:

1. To provide a guide to the research literature for use by science education researchers. As in fields such as history, it is useful to researchers to have comprehensive guides to the literature. The serious researcher will, of course, want to go to the original report of the research for details of problem definition, research methodology, and results of a study.

2. To provide a concise review of science education research for use by teachers, supervisors, department chairmen, and policy planners. Some of the problems that practitioners and policymakers face today have been studied systematically by others. The volumes have indexes that can help locate studies according to science subject, level, and kind of study.

Search and Selection: Searches were made in the journals that ordinarily carry reports of science education research, The Review of Educational Research, The Education Index, bibliographies, and footnotes in books, survey studies, and yearbooks. The "Curtis Digests" contain some unpublished studies. The later "Reviews" have been limited to published studies.

The methods of selecting the studies for digesting and annotating vary somewhat from volume to volume.[2] The usual procedure was for the investigator to develop a bibliography of the titles of all articles, monographs or books during the period that might conceivably be reports of science education research. All of the reports were then read by the investigator, and the reports that were clearly not science education research were eliminated. For the Reviews of 1938-1947 and 1948-1952, a citation technique was also used, and one citation in a subsequent publication in science education served to place the study on the ballot. The list of studies and brief summaries were then evaluated by knowledgeable people in science education who had been active during that period. (The studies included in the first "Digests," were selected entirely by Curtis. For the Second and Third "Digests" he called upon all of the members of the National Association for Research in Science Teaching for help in making the selections.) The studies that were judged to be most worthy of inclusion were digested. In the Curtis

volumes, additional studies were listed in a supplementary bibliography. In the last three volumes of "Reviews," there are extensive annotated bibliographies of studies not digested.

Number of Studies

	Digests	Supplemental or Annotated
Curtis I to 1925	70	-
Curtis II 1925-1930	93	122
Curtis III 1931-1937	94	189
Boenig 1938-1947	78	78
Swift 1948-1952	44	99
Lawlor 1953-1957	21	135
TOTAL	400	623

Types of Studies: It has been suggested that science education research studies can be classified into four categories: empirical research, philosophical studies, policy studies, and developmental research.[3] Empirical studies usually involve the collection of data concerning the behavior of students, teachers or other subjects; experimental studies are examples of empirical studies. Philosophical studies may involve analyses of assumptions, clarification of problematic situations, and exploration of possible consequences of proposed actions; the examination of the possible consequences of a proposed new approach to science teaching is a philosophical study. Policy studies are undertaken to make our policy decisions more intelligent; historical, comparative and status or survey studies are policy investigations.

Developmental studies involve the development and testing of new programs or materials, course development and test construction are developmental studies.

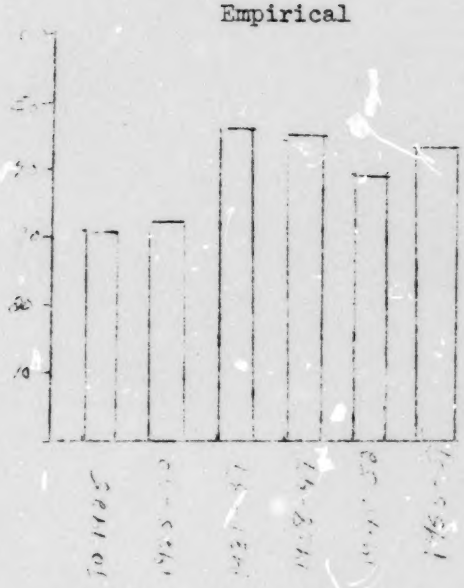
The digests have been examined and arbitrarily classified into these four categories. The following table shows the percentage of the digests in each of the categories in each of the periods:

Types of Studies in Percent

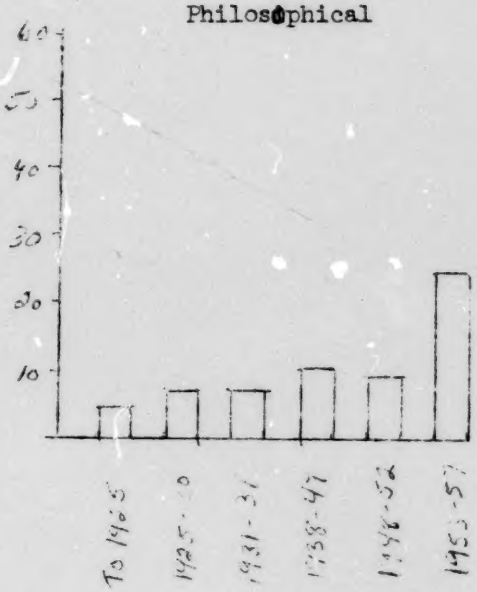
	Empirical	Philosophical	Policy	Developmental
Curtis I to 1925	31	4	57	7
Curtis II 1925-1930	32	7	55	6
Curtis III 1931-1937	46	7	38	9
Boenig 1938-1947	44	10	38	6
Swift 1948-1952	39	9	43	9
Lawlor 1953-1957	43	24	9	24

The following graphs depict the relative emphasis upon the variour types of studies during each of the periods:

Empirical

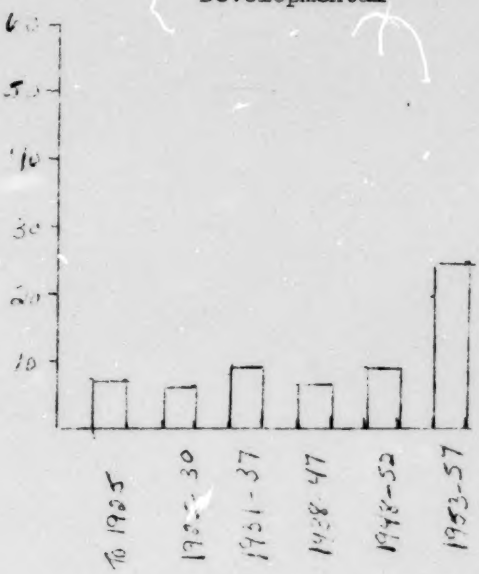


Philosophical



Policy

Developmental



Questions from Forty Years

Among the functions of historical studies are to make it possible for us to build on the work of the past, to raise questions about the present, and possibly to illuminate the future. Based on "Forty Years of Research in Science Education," the following are some of the questions that can be raised:

Have we improved our research methodologies in science education? In his second volume (for some reason he did not do this in the third volume), Curtis raises some serious criticisms concerning the research studies he has reviewed.[4] It might be useful for us to consider these criticisms in terms of our present-day research. These are his criticisms:

1. "Failing to state the problem definitely."
2. "Assuming the equivalence of experimental groups without taking adequate steps to insure this equivalence."
3. "Securing equivalence of groups upon a basis other than that in terms of which results are measured."
4. "Failing to isolate the experimental factor."
5. "Delimiting too rigorously the teaching methods under investigation."
6. "Assuming the definitions of the teaching methods under investigation to be standard, i.e., commonly accepted."
7. "Failing to report the technique in sufficient detail."

8. "Mingling findings and conclusions with details of methods."
9. "Evaluating on the basis of only one criterion, when that criterion is but a single element in a more complex process or situation."
10. "Employing crude subjective tests in measuring results."
11. "Making gross errors in recording data."
12. "Including personal opinions among the findings and introducing personal bias into the investigation."
13. "Making sweeping generalizations from obviously insufficient data."

What is the role of research in policy making? One of the striking results of the analysis of the types of science education studies is the apparent decline in policy studies. It is conceivable, but unlikely, that this might have been because many of the policy studies are not published. But it is more likely that there was a decline in the number of such studies.

There apparently continue to be few policy research studies. A perusal of the contents of Volume 10 of the Journal of Research in Science Teaching reveals only one study that was of the policy type. Also it has been a number of years since we have had nationwide studies of the status of elementary and secondary school science. Are we to conclude that wise policies can be developed without a sound information base? Or, have science education researchers concluded that research does not influence policy so why bother?

What is the role of policy statements in science education? In reading many of the digests of investigations carried out during the forty-year

period, the influence of historic policy statements become apparent. The Thirty-first Yearbook of the National Society for the Study of Education, A Program for Teaching Science, and the Progressive Education Association book, Science in General Education, clearly influenced research as well as practice in classrooms. It has been fifteen years since the last yearbook devoted to science education, and there have been very few other science education policy statements. Is there a need for a deliberate analysis of where we have been and where we can go?

Is science education cumulative? Ideally, research is based on the cumulative work of those who have preceded us. As Newton said "If I have seen farther, it is because I have stood on the shoulders of giants." Certainly, there have been giants in science education research, even a casual perusal of these "Digests" evokes respect for the imagination and certainly the tremendous energy of some of the early investigators. If science education research is a cumulative undertaking, then the early researchers built the base.

In the first "Digest" there are a number of experimental studies in which various approaches to teaching were tested. Also, there were a number of studies of children's interests, and in this and the second "Digest," there are analyses of what future science citizens need to learn. Are the results of these studies of lasting value or do conditions change sufficiently so that their value is transitory. Certainly, it is significant to find out whether science education as a field is cumulative or transitory.

In his analysis in the second "Digest," Francis Curtis suggested that one of the gravest needs was for "Multipled" repetitions of studies already made. This need probably still exists, but now apparently we find repetitions that are carried out, in some cases, without an awareness that other similar studies have been done. Perhaps, the classic example is the more than one hundred studies contrasting laboratory and lecture demonstration approaches to teaching. Replication studies are to be encouraged, but surely it is desirable that they build on each other.

In summary, these digests and annotations make more readily available to science education researchers and teachers, supervisors and policy-makers the fruits of forty years of work in science education. Hopefully, this work can also help illuminate our present problems and future possibilities.

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2. For a critique of the selection process, see Elizabeth Phelan Lawlor and Francis X. Lawlor, "Methodological Problems Encountered in the Review of Research in Science Teaching," Science Edcuation, 56, 359-368.

3. Willard J. Jacobson, "Approaches to Science Education Research: Analysis and Criticism," Journal of Research in Science Teaching, 7, 217-225.

4. Francis D. Curtis, Second Digest of Investigations in the Teaching Science (New York: Teachers College Press, 1971. pp. 5-7.)